DOCUMENT RESUME

ED 369 681 SO 023 728

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TITLE A Study of Sex Differences among Art Students on Spatial Abilities.
PUB DATE 90
NOTE 15p.
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Ability Identification; Aptitude Tests; *Art Education; Artists; *College Freshmen; Higher Education; *Majors (Students); Research Methodology; *Sex Differences; *Spatial Ability
IDENTIFIERS Eliot Spatial Dimensionality Test Battery

ABSTRACT

This study reports data concerning spatial abilities of professional art students. It is part of an ongoing collection of data on spatial abilities on the incoming freshman class at a large major private art school. The battery of eight tests has proven to be highly reliable and valid in previous studies with the specific population. Researchers examined 112 subjects in the fall of 1987 using the Revised Eliot Spatial Dimensionality Test Battery. The data showed no significant sex differences between male and female students. Possibly, the often observed sex differences on spatial tests that seem to favor the male subjects do not so differentiate in professional art school. Experts have identified such spatial skills as components of general fluid cognitive abilities, perceptual field independence, and the ability to perceive three dimensional spatial relationships. All these elements would seem to be the key skills for success in art school. The correlational data showed these skills to be highly related to each other for the specific population of the art school student. The construct validity of the spatial tests for study group was very high; for that reason, researchers selected the population for an extensive exploration of spatial abilities over a period of years. Findings may identify skills needed for success in art school and some of the positive outcomes of visual artistic education as a whole. (Author/SG)

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A STUDY OF SEX DIFFERENCES AMOUNG ART STUDENTS ON SPATIAL ABILITIES

BY

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FALL 1990

SO 023 728

Prepared for:

Submitted to:

ABSTRACT

This study reports data relative to the spatial abilities of professional art students. It is part of an on going collection of data on Spatial abilities of the incoming freshman class at a large major private art school. The battery of eight tests has proven to be highly reliable and valid in previous studies with this specific population. One hundred and twelve subjects were tested in the fall of 1987 on the Revised Eliot Spatial Dimensionality Test Battery. The data showed no significant sex differences between male and female students. It may be that the often observed sex differences on spatial tests which seem to favor the male subjects do not so differentiate in a professional art school.

The spatial skills conceptualized in this study have been identified as components of general fluid cognitive abilities, perceptual field independence, and the ability to perceive three dimensional spatial relationships. All these elements would seem to be the key skills for success in art school. The correlational data showed these skills to be highly related to each other for our specific population sample of the art school student.

The construct validity of our spatial tests for this specific population was very high and for that reason the population was selected for an in depth exploration of spatial abilities over a period of years. The data may indicate some of the positive skills needed for success at art school as well as some of the positive outcome of visual artistic education as a whole.

BACKGROUND

Eliot (Eliot, 1984) began to collect a group of data from the incoming freshman classes at a large private art school. His test battery consisted of a group of spatial visualization tests which had proved to be reliable and valid in previous research efforts. The fall 1984 and 1985 test samples were used to develop and standardize a test battery for this specific population which consisted of the following tasks:

Embedded figures test (ets)

Twelve items were used as a measure of figure and ground differentiation and the ability to resist closure as a component of perceptual field independence. (Witkin, 1963) (McWhinnie, 1965)

Card rotations tests

This one hundred and twelve item test measures the ability of a subject to differentiate between objects which are either turned or flipped. This task is basically a two dimensional test measuring abilities at figural rotation.

Paper folding task

Ten items form the structure of the intellect tests were selected to measure how accutely a subject can visualize what a folded and cut piece of paper would look like when it is unfolded. This is a two dimensional task involving unfolding.

Horizontal and vertical rotations

A nine item test developed by Eliot in 1974 to test ability to deal with rotations on a two dimensional context.

Card perspectives

A nine items test developed to measure rotations in a three dimensional context.

Copying test (ets)

A thirty-two item test of the ability to keep in mind a pattern on a two dimension problem as a measure of field independence.

Voculary test (ets)

An eighteen item measure of verbal abilities suitable for the high school or the entering college student

The complete battery of tests were used to test the art students in 1986, 1987, 1988, 1989 and 1990. The basic purpose of this study was to develop a data bank of test scores on the spatial abilities of a group of professional art students who would be expected to do very well on such tasks of non-verbal abilities and in matters of fluid cognitive functioning. This particular paper will deal specifically with the data from the 1987 data set and has focused upon the specific question of sex differences in perceptual spatial tasks.

This present 1987 sample tested the capacity of the Eliot test battery and the art school data base to be able to be utilized in a wide variety of studies which could focus upon various aspects of the fine art student as well as provide comparative data on the spatial abilities against which data from other population samples could be compared.

A study now in progress by Roach (Roach, 1990) will address question of the predictive validity of the spatial test battery with reference to performance in art school. There may also be some indications from the Roach study in terms of the diagnostic abilities of the test battery to locate specific skills which could be improved upon in order to benefit the students' overall performance at art school. The Roach study will demonstrate the ability of the spatial test data base to relate to and to provide data a series of studies of the talented and gifted in the visual arts. This specific study has demonstrated the ability of this data based to provide relevant data on the general question of sex differences in spatial abilities which could be related to educational questions for the general populations as well as for the special population of the professional art student.

METHOD OF ANALYSIS

The test provides scores on each of the eight subtests which were used in a general correlational analysis. In addition we tested a series of sums or combined scores on several dimensions of interest which were:

<u>perceptual field independence</u>

embedded figures

copying test

<u>field dependence</u>

pattern folding

card rotations

Vertical and horizontal rotations

two dimensional problems

patterns

card rotations

copying

embedded figures

Vertical rotations

three dimensional problems

perspective

Surface development

The correlations demonstrated the predicated relationships among the specific test variables as well as the above grouped dimensions.

THEORIES OF FLUID AND CRYSTALLIZED ABILITIES

In our studies of college art students we have sought to study the relationships of spatial visualization and abilities as a part of cognitive theory which has conceptualized intelligence as a combination of fluid and crystallized abilities. (Lohman, 1990) Tests of fluid abilities seem to require novel problem solving, much like many of the intelligence tests developed in the first half of this century, particularily the non-verbal and spatial tasks. These tests require subjects to reason with moderately novel figure or symbolic stimuli. For this reason Lohman found that such tests often load strongly on the g-f (fluid intelligence factor) (Lohman, 1979). Tests of spatial or figural reasoning tasks have continued to play a prominent role as measures of general cognitive abilities particularily those conceptualized as g-f (fluid measures).

As with verbal abilities, cognitive research on spatial abilities may be divided into two general categories which are:

(A) attempts to develop general theories of spatial thinking that ignore individual differences. (Pinker, 1984)

(B) attempts to explain individual differences on existing tests of spatial abilities either through correlations between scores on tests and performance or through the construction of information processing models for particular spatial tasks. (Pellgino and Kail, 1982)

Most spatial tests are process intensive and although spatial knowledge has an important impact on spatial problem solving whether subjects solve such problems depends heavily on the process they employ during the test taking itself. (Lohman, 1988)

In a recent important article Lohman has described these abilities in great detail:

"Theories of spatial thinking (Kosslyn, 1980) distinguish two types of spatial knowledge: knowledge best molded by quasi-pictorial mental representations (e.g. appearance of a particulars object) and knowledge best modeled by abstract, proposition based memory representations (concepts of symmetry, proportionality closure). Each type of representation can be transformed by a different class of mental operators or procedural knowledge. Quasi-pictorial representations can be subjected to various analog transformations such as rotation or synthesis (Shepard and Cooper, 1982). Propositional representations can be subjected to the same general and specific cognitive operators (e.g. means ends analysis) that can be applied to propositional knowledge derived from other sources (e.g. linguistic inputs). Transformations such as rotation, then, are of interest primarily for the constrains they place on the type of mental representations used. Thus, many spatial-ability tests present items which seem to require for their solution analog transformations such as rotation, reflection, transposition, or synthesis." (Lohman, 1990, pp 346).

Lohman has presented a very clear and concise summary of the components of the spatial tests that we have tried to put together over the past six years to measure the abilities of the professional art student.

For a number of years people in art education have observed the following general characteristics about art students:

(a) they tend to be non-verbal and do not perform well on verbal one measures used in predication of school success.

(b) they tend not to show they typical sex differences either in attitudes in tests of perceptual and spatial abilities

(c) the components of professional art education seem to call for and reinforce those specific visual skills that are represented in the spatial tests and described by Lohman as component of the general factor of fluid intelligence.

Our studies of the professional art student can be conceptualized as a study of the factors of fluid intelligence and it is hoped that by a study of several groups of college art students we will be able to generalized about the interrelationships of these spatial skills for the general population.

"Research on how subjects solve spatial tests has turned up several surprises. One persistent finding has been that all subjects rarely solve figural tasks in the same way. For example, in a series of experiments on visual comparison processes, (Cooper, 1982) identified two markedly different strategies. Some subjects appeared to reply on a serial, analytic process to compare forms whereas, others relied on a parallel, holistic process. Complex task such as the paper-folding tasks or form board tasks commonly seen in mental tests, elicit an even wider range of alternative solution methods. Some subjects solve items on such tests by generating mental images that they then transform holistically. These high spatial subjects excel in generative retaining, and transforming mental representations that preserve information about the confirmation of a figure. They also use their spatial knowledge to decompose unfamiliar visual shapes into simpler, more familiar shapes. Other subjects rely on general reasoning skills or external aids (such as line drawings) to solve problems. Others use still different processes. But most subjects use more than one type of processing, generally shifting from one strategy to another as problems increase in difficulty (Lohman, 1988).

Such within-subject variability in solution strategy challenges simple information-processing models of spatial tests. Strategy shifting may partially explain why spatial tests are often good measures of g or of g-f. Appropriate flexibility in adapting solution methods to meet personal limitations and changing item demands appears to be a central aspect of any process theory of g-f. (Snow and Lohman, 1989) (Lohman, 1990, pp 346)

The elements of flexibility and strategy shifting have long characterized not only the art student but are important ingredients of programs of visual arts education. Therefore an in-depth study of the professional art student may give insights into the nature of the fluid dimension of general intelligence that no other special population could render to the researcher in cognitive science.

Results:

There was only one significant sex difference on the 1987 data set which favored the female performance on the SOI a pattern folding task. The professional art school sample since it is highly self-selective on these specific skills, it would seem that those sex differences which hold for a general population do not characterize the fine arts student.

TABLE ONE

COMPARATIVE STUDY

Art and Non-Art

[1987 Data Set]

	1987 Data Set		Non Art Standardization Set	
	Mean	SD	Mean	SD
EFT	3.46	2.70	2.87	2.74
Card Rotations (A)	96.64	36.82	55.16	21.78
Card Rotations (B)	29.71	14.29		
Paper Folding	2.20	1.02	2.85	2.48
Surface Development	1.38	1.25	10.72	5.45
Rotations	3.16	1.37	4.52	2.18
Perspectives	1.54	.92	6.47	2.61
Copying	24.83	9.54	13.59	4.52
VOC	2.06	1.18	9.78	3.02

*New scoring system credit given for couple sequence only.

The data in Table one shows some of the mean differences between the art school sample and the more general population.

TABLE 2

Means and Standard Deviations for the subtests of the SDT and the composite SDT score.

[Standardization data]

Non-Art data

	Male		Female		Total	
	Mean	SD	Mean	SD	Mean	SD
Test						
Embedded Figures (12 items)	2.87	2.74	2.60	2.5	2.87	2.74
Card Rotations (112 items)	63.53	22.17	47.59	18.47	55.16	21.78
Paper Folding (10 items)	3.33	2.79	2.41	2.08	2.85	2.48
Surface Development (30 items)	11.71	5.52	9.83	5.24	10.72	5.45
Horiz-Vert Rotations (9 items)	5.27	2.14	3.83	1.99	4.52	2.18
Cube Perspectives (12 items)	7.10	2.61	5.89	2.48	6.47	2.61
Copying (32 items)	15.04	4.09	12.28	4.40	13.59	4.52
Vocabulary (18 items)	9.48	2.80	10.04	3.18	9.78	3.02

TABLE THREE

Means and Descriptive Statistics on Spatial Tests [Art School]

[1987 Data Set]

TEST	Mean	SD	N
Card Rotations (A)	36.82	96.64	129
Card Rotations (B)	14.29	29.71	111
Surface Development	1.25	1.38	131
EFT	3.46	2.70	131
SOI	2.20	1.02	131
EPR	3.16	1.37	131
SFP	1.54	.92	131
Copy	24.83	9.54	130
Voc A	2.06	1.18	130
Voc B*	-1.12	1.42	130

*Card Rotations (B) revised score system correct responses only.

* Voc B revised score system with permanent factor for incorrect responses.

TABLE FOUR

Sex Differences on Spatial Dimensions Test [Art School]

1987 Data Set

Test Variable	DF	Fratio	F Prob Value	
EFT	1,129	.0108	.9173	N.S.
SOI	1,129	3.6557	.05	*
EPR	1,129	.0653	.7987	N.S.
SFP	1,129	2.1093	.1489	N.S.
Copy	1,128	.7258	.3958	N.S.
Vocabulary	1,129	.2350	.6287	N.S.
Card Rotation	1,128	1.46	.13	N.S.
Surface Development	1,128	1.07	.80	N.S.

*significant at .05 level for finals on SOI (pattern folding test).

DISCUSSION AND CONCLUSIONS:

The findings of no significant sex differences on the SDT scores for the 1987 art school data set is not consistent with significant differences found in the 1989 and 1990 data sets for the same general professional art school population. The general population is the same and there was no difference between he mean scores of 1987, 1989, and 1990 data sets yet when analyzed for gender differences. The observed sex differences in both 1989 and 1990 data sets are consistent with the research literature while the 1987 data appears to be different. At this point we have no explanation for the lack of differences in 1987 data set.

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